

REMARKS/ARGUMENTS

This responds to the issues presented in the Official Action of January 21, 2009, a Final Rejection and accompanies a Request for Continued Examination.

Reconsideration of this application is requested. Claims 31-35, 37-39, and 41-61 will be pending in the application subsequent to entry of this Amendment.

The claims have been amended in order to address the issues raised in the Official Action, in particular the claim clarity rejections directed to claims 31 and 51. In the previous response an error was made in amending claim 31 in referring to the particles "containing metal impurities". This phrase should have read "containing contaminating impurities". Claim 31 is above amended to change "metal" to "contaminating". Also claim 51 is amended to refer to "particles" which have antecedent in claim 31.

A number of claims are rejected as being anticipated by GB 2121441 of Down. Down teaches a method for purifying metal particles formed from powder or sponge, of Ti, Zr or Hf, produced by the Kroll or Hunter processes (page 1, lines 117-120). In the Kroll process, a TiO_2 ore is reduced with carbon and then treated with chlorine gas, to form TiCl_4 . The TiCl_4 is then reduced with liquid magnesium in a stainless steel vessel to produce Ti metal, in the form of sponge, and MgCl_2 . The Hunter process is similar, but uses sodium to reduce the TiCl_4 instead of magnesium. References describing these processes are easily available, for example on Wikipedia.

In paragraph 7 on page 3, the Examiner states that "Down teaches that the method is used to purify metal particles made by an electrochemical process". This is not so -- neither Kroll nor Hunter is an electrochemical process. Both processes are purely chemical. Therefore, Down does not teach a method for purifying metal particles made by an electrochemical process.

What Down does teach is a method for purifying the metal particles by feeding the particles through a plasma within a plasma reactor (page 1, lines 91-100). Claim 31 has now been amended to be limited to the purification of metals in a heat source that does not include a plasma. The heat sources listed in claim 31 as amended are drawn from claim 36 and from the description at page 4, line 27. Claims 36 and 40 have been deleted without prejudice or disclaimer.

The applicant has appreciated that there are a number of problems with using plasma processing for the purification process, such that the plasma process described in the Down patent would not work for the metal particles manufactured by an electrochemical reduction process, which are the subject of claim 31.

The main problem is that plasma processing tends to vaporize particles rather than to melt them. Plasma flames are somewhat “viscous”. A particle hitting a plasma flame at a large angle is quite likely to bounce off. To make sure that all particles go through the flame they have to be introduced along the flame axis, but even then problems arise. The core of a plasma flame can be in excess of 15,000 Kelvin while the edge may be only 1,000 Kelvin. The temperature regime a particle sees therefore depends on its trajectory through the flame. Consequently, particles passing through a plasma flame are subjected to a variable and inconsistent heating process. Ones that go through the center of the flame are completely vaporized, while ones that go through the edge may be only partially melted. Hence, it produces an undesirably non-uniform product. Vaporization of particles can be highly problematic and even dangerous. For example, Ti particles that are vaporized in a plasma flame may re-condense to form extremely fine particles, which are extremely pyrophoric and likely to explode unless handled very carefully.

Further, the applicant has appreciated that plasma heating may be too rapid and violent for the purification process of the invention. Particles manufactured by an electrochemical reduction process are typically porous, and may contain entrapped materials such as CaCl_2 or Ca metal (with reference to the electrochemical reduction process described in the present application, for example at page 3, lines 8-10 and in WO 99/64638, mentioned at page 1, line 9) if such a particle is heated too rapidly, then it may be blown apart. Slower, more controlled heating may be desirable, and this is not possible using a plasma.

In the present application, the particles are described as being permitted to free fall past or within a heat source (see, for example, claim 38). By contrast, in Down the particles are fired horizontally into a plasma, and are not in “free fall”.

In order to avoid particles bouncing off a plasma flame, they need to be introduced into the flame axially. This means passing them through the plasma torch. The electrodes of a plasma gun are typically made of thoriated copper. Metal particles are abrasive and are likely to erode small parts of the plasma gun and introduce them into the plasma flame. Hence, copper

and thorium contamination of the product particles is likely. Since the aim of the invention is to obtain high purity material, even trace contamination by thorium is not desirable. It should be noted that thorium is a high vapor pressure material and would not be volatilized and removed in the same way as the contaminants introduced during electrochemical reduction.

As defined in claim 31, the method is used for purifying metal particles manufactured by an electrochemical reduction process. One characteristic of such particles is that they tend to be very irregularly shaped. They do not flow very well as a powder. This is one reason why the invention is advantageous for treating such particles, as it may enable them to be spheroidized. Such particles do not flow well and therefore introducing them into a plasma gun and ensuring that they all take the same trajectory through the flame, in order to expose them to a consistent temperature distribution, would be extremely difficult.

Finally, plasma processing tends to be very expensive. It requires large amounts of energy and, for this process, argon or helium would be needed. Most plasma processes are based on nitrogen, for cost reasons, but this cannot be used because it reacts with titanium. Helium is technically the best option but is very expensive.

On page 6 of the Office Action, the Examiner argues that Down anticipates claims 60 and 61 even though he does not teach the concentrations of contaminating impurities specified in those claims. He argues that this feature would have been inherent in Down's process "as the similar material treated similarly must inherently have the same properties". In fact, the materials are not "treated similarly". As noted above, claim 31 relates to a method for purifying metal particles manufactured by an electrochemical reduction process, and Down describes metal particles manufactured by a completely different, entirely chemical, process. Consequently, the material described in the present application is not similar to Down's material. Further, electrochemical reduction of metals almost invariably uses a CaCl_2 electrolyte, and Down makes no mention of removing either CaCl_2 or Ca metal as contaminants. Again, for this reason, the material in the invention is not similar to that of Down.

Magnesium is deleted from claim 45 in order to agree with this argument.

In paragraph 10, the Examiner rejects claim 53 as unpatentable over Down in view of US 6,452,140 of Motokawa. Applicants disagree.

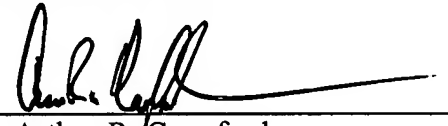
Motokawa describes a method for forming spherical materials using a levitation melting technique. Specifically, Motokawa describes heating volumes of 1 gram of a variety of oxides (see Example 1, Example 2 and Example 3 of Motokawa) using a laser to form individual spheres of material. Motokawa makes no mention of purification and is not concerned with the processing of metal particles. Motokawa only uses much larger volumes of metal oxides. Consequently, it is difficult to see that the skilled person would consider combining the teachings of Motokawa and Down. In addition, heating in a plasma flame, as described above, is a somewhat violent heating method. Motokawa's aim is to produce almost perfect spheres of material and the use of a plasma flame, involving highly variable temperatures and very fast moving plasma currents, would be completely incompatible with Motokawa's method. Consequently, the Examiner's argument based on the combination of these documents seems ill-conceived.

For the above reasons it is respectfully submitted that the claims of this application define inventive subject matter. Reconsideration and allowance are solicited. Should the examiner require further information, please contact the undersigned.

Respectfully submitted,

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